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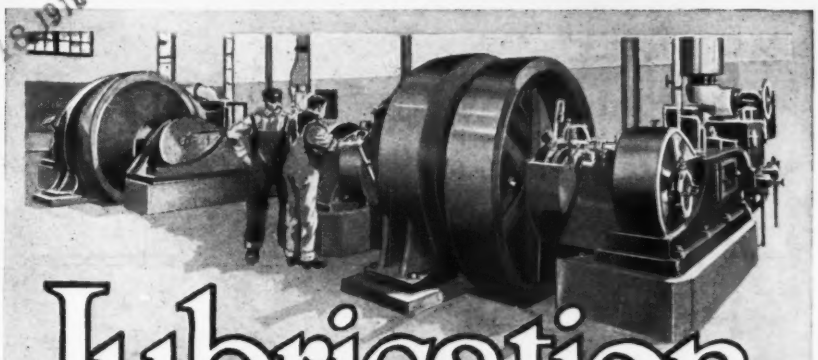

Lubrication

JANUARY, 1916

Vol. III No. 3

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The Diesel Engine, by E. A. Garrett of the Busch-Sulzer Bros. Diesel Engine Company

Viscosity—Its Relation to Practical Lubrication

Reclaiming Oil

Published by
THE TEXAS COMPANY
New York

TEXACO URSA OIL FOR DIESEL ENGINES

WE have studied Diesel Engines, both abroad and in this country, and have developed in TEXACO URSA OIL, a lubricant of unusual suitability for this class of work.

It is interesting to note that the Diesel Engine, pictured in this issue, was the unit exhibited at the Panama-Pacific Exposition, and that TEXACO URSA OIL was used for the entire lubrication of this engine.

This unit has since been purchased and installed by a Southwestern Power Plant, and is still using TEXACO URSA OIL with eminent success.

We shall be pleased to answer any requests for further information on this oil.

THE TEXAS COMPANY

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St. Louis Youngstown

LUBRICATION

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Those who fail to receive LUBRICATION promptly, will please notify us at once and will confer a favor by promptly reporting change of address.

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EDITORIAL

In this number we publish an article describing the Busch-Sulzer Diesel Engine. This article is written by Mr. E. A. Garrett, who is associated with Busch-Sulzer Bros. Diesel Engine Company, and in which he explains this type of engine from the manufacturer's standpoint.

This article is the first of a series contributed by the manufacturers themselves, and we believe that the collection of the future numbers of "Lubrication" should carry a comprehensive outline of the leading Diesel Engine types in America.

We know that the Diesel Engine is attracting much interest in this country and are pleased to offer these articles, which will be authoritative in every respect.

In our next number, we propose to run a few small items concerning Texaco Crater Compound.

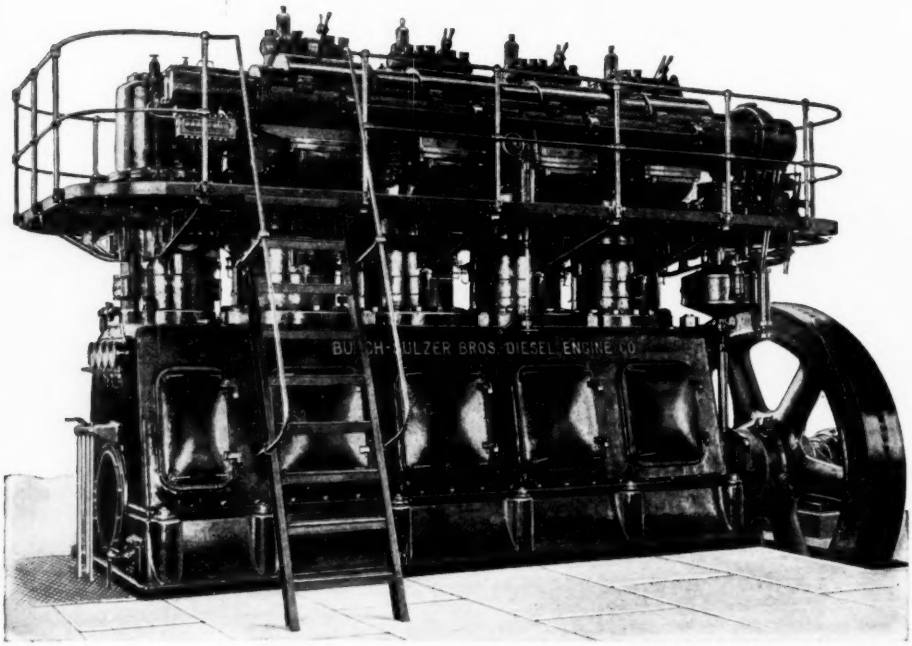
This is a remarkable lubricant for gears, wire ropes, cables, etc. We have had considerable success with this product in its use as a lubricant in places made difficult by high radiated heat, water, atmospheric conditions, exposure to chemical fumes, flying dust, etc.

This product has shown a wide range of use and a telling economy in places so exposed, indoors and outdoors. It is used in iron and steel works, in mines, on conveyors, in cement mills, paper mills, rolling mills, traveling cranes, locomotive hoists, dredges, and in numerous other places.

Texaco Crater Compound is exciting unusual interest because of the fact that it is filling a long felt want, and we will be pleased to give any further information upon request.

On page six will be found an article on Viscosity and its application to lubricating tests and problems.

We cannot over-estimate the importance of this consideration to all purchasers or users of lubricants, and we would particularly call attention to that portion of the article which deals with the instruments used in the tests, for on their suitability and accuracy rests almost entirely the value of the determination of this all-important characteristic of lubricants.



THE DIESEL ENGINE

By E. A. GARRETT

Busch-Sulzer Bros. Diesel Engine Co., St. Louis, Mo.

The Diesel Engine, illustrated in this issue, marked a noteworthy economic advance in prime-movers for the United States. It is a compromise between the high speed types of Europe and the excessively low speed types of this country; yet it is a notable feature of this engine that the piston speed remains slower than in most all the lower speed engines now on the market.

It is of a vertical, 4-cylinder, 4-stroke cycle, single-acting, enclosed crank-case, medium speed type. The illustration above shows a general side view of the 500 horsepower unit. The small cylinder at the left in the illustration is the 3-stage air compressor, which compresses the air used for starting and for the atomizing of the fuel as it is injected into the cylinders previous to and during combustion on the working stroke of the cycle. The governor is shown at the right below the gallery; the fuel pump is just above the gallery over the governor.

In this Diesel unit, by means of devices maintained in constant adjustment by the governor, the engine is made to automatically control all those factors varying with the load that influence its economy of operation.

They are:

(a) The air pressure for fuel atomization and injection.

(b) The period during which the

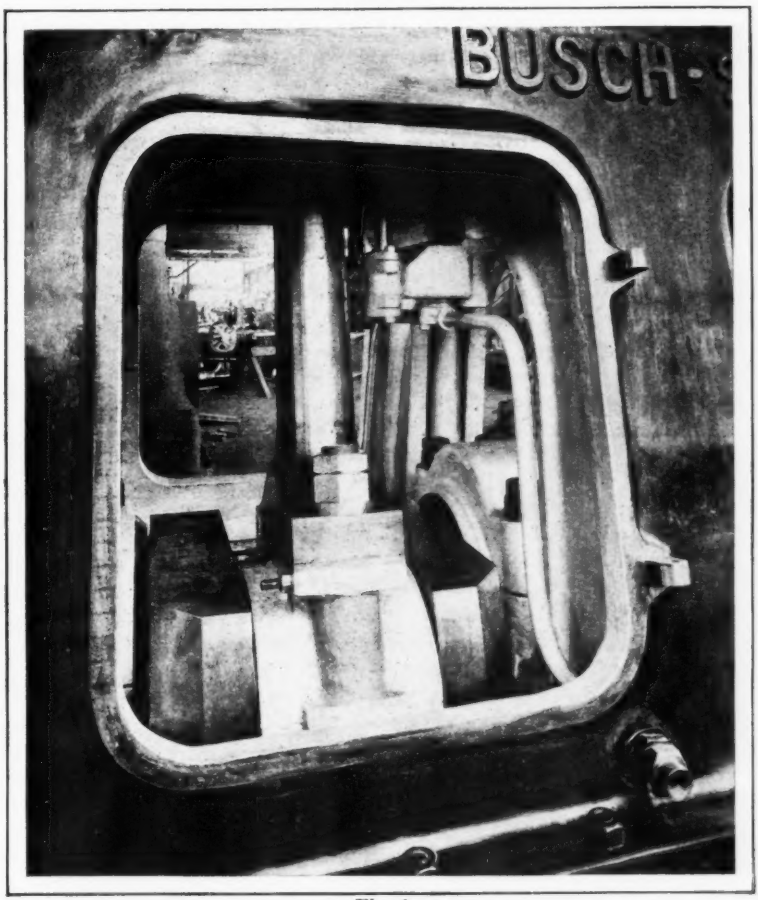


Fig. 1.

fuel valves are held open, and

(c) The lift of the fuel valve needles, i. e. the degree of opening of the fuel valves.

These adjustments are entirely aside from the chief function of the governor, which is speed control; and speed control, in all combustion engines, is in reality but another economy feature, inasmuch as it consists of measuring the fuel delivered to the fuel valves, the quantity being varied according to requirements of the load. The pumps supplying the fuel, of which there is one for each cylinder, are operated from a vertical lay-shaft turning at engine speed; thus arranged they deliver *two* measured quantities of fuel to each fuel valve before each opening thereof. Now, since the pumps are opposed, two being on the suction while two are on the discharge stroke, for the 4-stroke cycle 4-cylinder engine operating at 200 revolutions per minute with a power impulse each revolution, this means that the fuel delivered to the atomizers, with

each fuel pump discharge stroke, is the exact quantity necessary to care for the load for just one four-hundredth of a minute interval.

The cam-shaft is located on a level with the cylinder heads, which does away with push rods, simplifies construction, reduces the number of parts, and arranges those parts which should have regular inspection at a convenient height where they can be readily examined by the operator. The cylinders and cylinder heads are cooled in the usual manner; but the system of water cooling in this particular unit also cools the pistons, and the exhaust pipes, this assuring a cool engine and a cool engine-room. A serious attempt has been made by the manufacturers to provide all the refinements and economy devices sanctioned by an extensive experience.

Fig. 1 shows clearly the accessibility of the enclosed frame. This construction is more rigid than the "A" frame, ensures quiet operation and precludes the possibility of the escape of oil vapor into the engine-room, and flinging of lubricating oil.

The engine is equipped with a forced lubrication system operated by a rotary positive displacement pump, and contains oil filters in duplicate and an oil cooler. A schematic diagram of the forced lubrication system is shown in Fig. 2. Not only does the system lubricate the bearings, flooding them, so that the shaft and crank and piston pin boxes float on a film of oil, but the flow of oil serves to cool them at the same time.

The oil is fed at a pressure of 15 pounds per square inch and is carried from the main bearings through the shaft to the crank pin bearings and from thence through the connecting rods to the wrist pins. It is strained and cooled and used again and again, a very copious flow being provided.

A vital consideration in the choice of a prime-mover is the life of the equipment. This characteristic, so intimately associated with maintenance and depreciation, always deserves careful consideration. In Diesel installations more than five-sixths of the cost of a complete equipment is represented by parts entirely free from wear and tear. Compare this with an equivalent steam installation, i. e. engines, boilers, condensers, and all auxiliaries. The heavy and expensive parts of a Diesel engine are not subject to wear at all; while of the parts sometimes requiring renewal, a large majority will operate for years without replacement.

The parts susceptible to ordinary wear and tear are either inexpensive or easily repaired.

Complete and suitable lubricating and cooling systems, interchangeability of parts, rugged construction, and proved design cut maintenance charges to the minimum. This is especially true of Diesel equipment, which can be built successfully on no other basis. Dr. Diesel, before the American Society of Mechanical Engineers, remarked, regarding its manufacture—"The Diesel motor is not a cheap engine, and I would add a warning that the attempt should never be made to try to build it cheaply, by unfinished workmanship."

For maintenance and depreciation, 5 per cent is considered ample by the licensees of the engine in this country; and their experience covers fifteen years of manufacture. An example of the life that may be expected of the part

subjected to the severest usage is afforded by two ten-year-old engines, belonging to the Texas Power and Light Company, installed at Sherman, Texas, in 1904. The cylinders of these engines were rebored for the first time in July, 1914. These Diesels are operated on a 24-hour schedule, and each has averaged eighteen hours per day since installation. The efficiency of these units has not appreciably deteriorated, despite the constant service to which they have been subjected for the past 10 years. Considering the high depreciation and rapid decrease in efficiency of boiler-room equipment, the claim advanced by the manufacturers that a self-contained Diesel engine will outlive an equivalent steam plant, seems substantiated by this record.

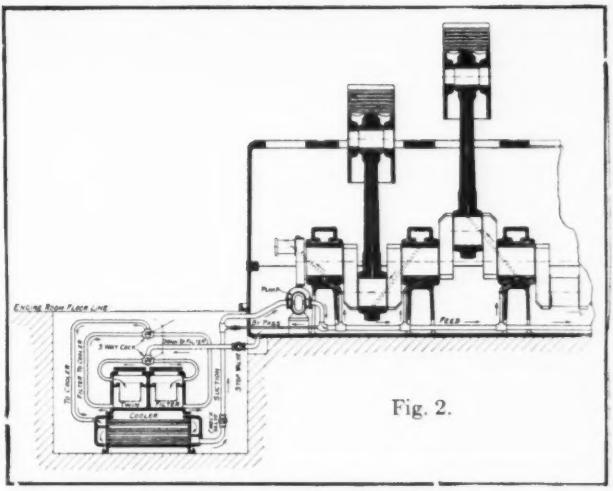


Fig. 2.

In the shops of the Busch-Sulzer Bros. Diesel Engine Co., where these engines are built, manufacturing and inspection are carried on under separate and distinct departments, neither of which is biased by considerations favorable to the other. This scheme of shop division makes it possible to obtain the highest standards of manufacture, and the interchangeability of duplicate and wearing parts.

In conclusion, it may be stated that the proper use of the Diesel engine generally falls into one of two categories:

(a) Constant operation at or near full load, under which circumstances its small consumption of fuel per unit of output is most noticeable, and under,

(b) Constant operation with an irregular load and a low load factor, as in central stations, under which circumstances its efficient operation at very light loads far outstrips any economy that can be obtained from equivalent steam equipment.

Economy is generally the determining factor in the selection of the Diesel engine, this factor including the sum of the costs of operation, maintenance, depreciation and capital charges. The relative cost of fuel oil and coal, on a B. T. U. basis, is the starting point from which the calculation is usually made. Scarcity of suitable boiler feed water, limited space available and instant readiness to start, regardless of the length of shut down, are other important factors that sometimes determine its selection.

The manufacturers will make the following guarantee as to fuel economy:

One horse-power on 0.43 lbs. or 0.06 gallon of fuel oil; or, stated differently, that 1 gallon of fuel oil will produce 16.6 horse-power hours or, approximately 11 kilowatt hours.

VISCOSITY—ITS RELATION TO PRACTICAL LUBRICATION

The work which a lubricating oil is called upon to do involves keeping the metal surfaces apart during the movement of one surface upon the other, and the accomplishment of this purpose with a minimum internal friction in the oil film itself.

Obviously, therefore, the oil must be selected with the pressure and speed of the bearing known and the frictional requirements of the oil itself thoroughly understood. The maximum requirement of pressure and the limitation of speed will determine the body which is necessary to keep the metal surfaces apart. This body is indicated by the relative fluidity of the oil, and is termed viscosity.

Viscosity is determined by a measurement of the time taken by a certain amount of oil to flow through a standard orifice at a certain temperature. A rough idea of the comparative viscosity of two oils at the atmospheric temperature can be obtained by taking four-ounce sample bottles filled with the oils and invert them quickly, noting the drop from the bottom of the bottle. The drop which leaves the bottom more quickly indicates lower viscosity or more fluid product; the difference of time between the drop would roughly indicate the extent of the viscosity variation,

For accurate determination in the laboratory, an instrument called a viscosimeter is used and the indicated time expressed in seconds. For instance, an oil of 200″ viscosity at 100° F. means that a certain amount of the oil will flow through the standard orifice in 200 seconds when heated to a temperature of 100° F.

There are a number of viscosimeters in use in this and other countries with varying standards of measurement and various methods of taking the test.

The one in most general use in this country is the Saybolt Universal Viscosimeter, and there is a decided movement toward its general adoption. This would be of great advantage to all oil users, as the practice of using different instruments makes the comparison of various tests difficult, if not impossible. This is particularly true because of the absence of any fixed relation between some of these instruments and the difficulty of converting the results obtained on one into the corresponding reading on another. At present it is advisable in every case where viscosity is specified that the instrument, the time and the temperature be stated so that the limitations required be thoroughly understood.

For instance: Viscosity taken on Saybolt Universal, Viscosity 300″ at 100° F., would give the necessary information. The temperature at which viscosities are taken in the laboratories of The Texas Company are 210° F. for cylinder oils and 100° F. for engine and machine oils, temperatures which are now being generally accepted as standard.

The viscosity of any oil varies at different temperatures and consequently the temperature at which the reading is taken is a necessary provision for any exact comparison. This variation of viscosity through certain temperature ranges is differ-

ent with oils made from different crudes, but has little bearing upon the value of the lubricant for use. The important point to the buyer of oil is the selection of an oil of the right viscosity at the working temperature. The body of the oil must be sufficient to keep the metal surfaces apart under the conditions of use, and the viscosity of the oil at some arbitrary temperature has no bearing upon its value under working temperatures, unless these approximate. Where, for instance, the average temperature of a bearing is 100° F., the viscosity of the oil at 70° F. is obviously of no moment, as the latter statement cannot be translated into working conditions; on the other hand, the correct viscosity to keep the metal surfaces apart at 100° F. would indicate the suitability of the oil at once.

While it is true that some lubricating oils lose viscosity at high temperatures somewhat more rapidly than others, they also increase in viscosity somewhat more rapidly at low temperature. There are some advantages in this gain at lower temperatures, as there is apt to be less waste of the oil in practical use. As the room temperature is usually considerably less than the bearing temperature, the oil in a gravity feed or hand oiler pours more slowly and consequently less is used—there is less dripping from the bearings.

The only important consideration, however, to be given to the viscosity of an oil is that it shall be of the correct viscosity for the conditions at the working mechanical temperatures.

Although the viscosity of an oil is its most important single characteristic for lubricating purposes, and one of the best guides to its value, this does not indicate that a high or low viscosity is the best for all purposes. The purpose of lubrication is to secure a film of oil just sufficient to keep the bearing surfaces apart at working temperatures. The viscosity of the oil should be determined, then, by the conditions under which it is to be used. If an oil is too light in viscosity it will permit metal contact with a consequent loss of power and bearing wear. On the other hand, if an oil of too great body is used, there will be unnecessary fluid friction, and again there will be a loss of power. The more viscous the lubricant, the greater the pressure which can be sustained; the viscosity of the lubricant should, therefore, be in proportion to the pressure. Heavy, slow-moving machinery requires an oil of high viscosity; light, swiftly-moving machinery requires just the opposite. Also high temperature conditions require an oil of higher viscosity than ordinary conditions. Most of the resistance or lost power in running machinery is caused by the internal friction or the fluid friction of the lubricant used. It is only occasionally through the use of a very improper oil or lack of feed of a proper oil, that actual metal wear on properly constructed bearings takes place.

The general law governing lubrication is that within certain limits a reduction in the viscosity of a lubricant will bring about a reduction in the co-efficient of friction, or in other words, a reduction in frictional heat and in lost power. However, different scientific tests have proven conclusively that this law must be modified in comparing oils from a paraffine base with oils manufactured from asphaltic base crudes. Tests, covering a wide range of conditions, have shown that the power consumed by the

internal friction of the heavier bodied asphaltic base oils is less than that consumed by the internal friction of lighter bodied paraffine base oils. This exception to the general rule of lubrication is due to the fact that oils manufactured from asphaltic base crude possess greater internal lubricating power than oils made from crudes from other sources.

Texaco lubricating oils are supplied from both asphaltic base and paraffine base crudes, according to the advantages of these oils for the specific purposes for which they are intended. It should be remembered in connection with this and similar tests for lubricants, that the selection by the refiner of the right oil and the processes of the refining through which it is carried, have a great deal more to do with the actual value of an oil and the lubricating conditions than mere ability to meet certain test conditions. Even the viscosity test, which is by far the most important in its bearing upon lubrication, will not give by itself an accurate indication of the lubricating value of an oil.

The success of Texaco Lubricating oils and their rapid development in all lines of industry has been due largely to the study and care in arranging the refining processes to produce material calculated to fulfil the purposes for which they are required, and in selecting oil which possesses the proper characteristics for the work it will have to do in industries. There may be just as much difference between two oils produced from the same crude for the same purpose as between two oils produced from different crudes. The crude is merely the raw material with which the refiner has to work, and its finished value to the customer will always be dependent upon the character of his operations and the methods which he adopts in preparing them. It is well to remember that Texaco Lubricating oils are valuable because they have been produced under Texaco methods and policies. They are prepared for the specific industrial purposes for which they are intended with the object of providing material suited to the conditions of practical use, so that the service will represent the greatest advantage to the consumer and consequently the greatest value to The Texas Company.

RECLAIMING OIL

From an Article in the Texaco Star
By Mr. WM. M. DAVIS

While engaged in reorganizing the lubricating practice at the mills of a large textile corporation, the writer found that the oils were received in barrels, a car load at a time, and kept stored in a shed where they were subjected to considerable heat so that the barrels soon began to leak, and that sawdust was spread over the floor to absorb the leakage. When the sawdust got saturated with oil it was shoveled into a wheel-barrow and taken to the boiler room to be burned. Of course the writer urged that tanks be provided to store the oil in; but as the management did not seem inclined to incur the necessary expense, it was decided to see what could be done to recover this oil. Some time previously we had installed a centrifugal

oil and waste cleaning machine for extracting the oil from the wiping rags and waste used in the engine-rooms, and we decided to see if we could recover the oil from the sawdust. At first we shoveled the oil-soaked sawdust into the perforated basket in the machine, but it soon clogged up the moving parts. We then made bags of burlap and filled them with the oil-soaked sawdust and packed the bags in the basket. This was a success. A few minutes operation of the machine threw out all the oil leaving the sawdust perfectly dry. We made a recovery of twelve gallons of oil from one large wheelbarrow full of oil-soaked sawdust, at very little expense for labor. This oil, after being filtered, was used over again. By being careful to gather up the oil-soaked sawdust at frequent intervals and extracting the oil, we were able to recover from $50.00 to $60.00 worth of oil per month that had previously been burned up at the boiler-room.

Another unusual case of oil recovery occurred at a large cement mill. At this mill they had two large Gates gyratory crushers, used in crushing the cement rock. We noted, in looking over the plant, that in oiling the step bearings the oilers pumped in so much oil that it overflowed and dripped out through the holes in the base plate onto the ground beneath the crusher. This oil, mixed with small pieces of broken rock which also accumulated under the crusher, formed a thick gummy mass of oil and stone two or three feet deep beneath the machine. When the accumulation got too deep it was shoveled into wheel-barrows and thrown out on the dump. As I was conducting some tests in another department of the mill and had plenty of time on my hands, I decided to see what could be done in the way of recovering this oil I worked out the following scheme: I procured two empty grease barrels and stood them in the room beneath the crusher. I ran a ½-inch steam pipe into one of the barrels to within a few inches of the bottom and filled the barrel about half full of water. On the top of the other barrel I fitted a strainer, using a wooden box about one foot square and about 6 inches deep with fine wire netting on the bottom, filled with closely packed excelsior. Having made these arrangements, I turned on the steam until the water in the first mentioned barrel was boiling. Then I had a laborer shovel into it the oil-soaked broken stone. As soon as it touched the hot water the oil separated and came to the surface, while the rock and other matter went to the bottom. By gradually shoveling in the oil and dirt we soon had the accumulation of oil up to the top of the barrel. We then turned off the steam, leaving just enough on to keep the oil hot so that fine particles of dirt could separate from this oil and settle to the bottom. Then we dipped the oil out and poured it through the excelsior into the empty barrel. In this way in a short time we recovered, at very little cost for labor, three or four barrels of oil that was perfectly clean and fit to use again. Of course, the heated barrel had to be emptied occasionally of its accumulation of broken stone and dirt, which when dried proved to be absolutely free from oil.

Put It Up to Your Wire Rope Manufacturer

FIND out why so many large manufacturers are glad to lay up their product in TEXACO CRATER COMPOUND.

They know that the hoisting efficiency is increased by the remarkable preserving and lubricating qualities of TEXACO CRATER COMPOUND.

Wire rope laid up in TEXACO CRATER COMPOUND—and given light treatments with it thereafter—will last longer. TEXACO CRATER COMPOUND protects it from internal friction, from wear, and from corrosion by mine waters.

It forms a pliable lubricating covering which does not shake off, peel or crack in cold weather.

It is unlike any other dressing on the market, because it is a lubricant throughout. It is made by a Company which understands lubricants, which has encountered, and satisfied practically every lubricating contingency met in plants of all types throughout this country.

It has shown almost unbelievable economies in hoisting work and for lubricating heavy gears.

It is not a new product, but one which this Company has thoroughly tested before we broke into print about it.

We are proud of TEXACO CRATER COMPOUND, and we have reason to be, for it fills a long-felt want, and has made us many friends.

In addition to the increase of life TEXACO CRATER COMPOUND gives to gears and ropes, it needs so little replenishing that the cost for lubrication alone is absurdly small.

Arrange for a trial. We shall be pleased to send you enough TEXACO CRATER COMPOUND to make a test on a rope or gearing.

TEXACO CRATER COMPOUND preserves new rope and checks the ravages of wear, weather, and mine acid corrosion on the old rope, rendering it serviceable for a long time.

Put it up to us to make good.

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